option to simply omit fat from food. Even so, it is worthwhile to reduce fat in food by substituting it with other materials, preferably those that can mimic fat's organoleptic and functional properties. A wide variety of fat replacements and substitutes have been marketed for this purpose, including sucrose polyesters, pectin, carageenan, protein microparticulates, beta-glucans, and hemicelluloses. However, to date, rice flour derivatives of various types have shown the most promise in serving as acceptable fat replacements. A carbohydrate product that should look and act like fat must have low moisture content, e.g., under 50%.

Rice starch plant material has a polymer chemical composition of thousands of anhydroglucose units (C.sub.6 H.sub.10 O.sub5), and is both a polysaccharide and a carbohydrate. Rice flour molecules exist as essentially unbranched chains consisting predominantly of 1,4-linkages between the anhydroglucose units, known as amylose, and as branched amylopectin chains consisting of both 1,4- and 1,6-linkages. Linear, short chain sections of the amylopectin molecule are connected to the longer backbone, and are terminal amylose groups of about 10-50 anhydroglucose units.

Rice flour occurs naturally in plants in the form of granules having an average size of 5-100 microns, with thousands of individual rice starch molecules tightly bound together. Unmodified rice starch granules are insoluble in cold water, but can be dissolved by heating at a temperature of 70°-90°C at atmospheric pressure. When the granules swell and rupture a gelatin forms that is deliberately induced in traditional cooking.

Waxy rice is a short-grain type of rice with less than 1% amylose. A favorable soft texture in waffles and pancakes can obtained by using about 5%-10% waxy rice flour. Flour-water pastes show no syneresis or retrogradation in freeze-thaw stability tests, but medium-grain rice flours produce

curdled pastes, and long-grain rice flours become rigid sponges. Medium-grain rice flour has a lower amount of amylopectin starch than short grain.

In Japan, rice flours from washed broken rice or milled rice are prepared from both waxy and nonwaxy rice. The flour for rice noodles is pulverized from non-waxy rice with a beater, roller or stamping machine. Rice flours are conventionally used in the preparation of rice noodles, extrusion-cooked baby foods, unleavened breads, rakugari rice cake, senbei and arare rice crackers, uiro rice pudding, and other Japanese rice products. Gelatinized rice flours are also prepared from both waxy and non-waxy Japanese rice. Milled waxy rice is steamed, converted into a dough, and pulverized. The flour is then typically used for making rice cakes.

Extrusion cooking is conventionally used to produce gelatinized waxy rice flour to avoid the tedious and more traditional Mochi process. Extrusion cooking uses rotating screws to force a relatively dry mass down a barrel, e.g., 10-40% moisture. A large motor is used to turn the screws. A restriction at the outlet of the barrel causes the food to pressurize and heat up in the barrel very quickly. Part of the mechanical energy is also used to squeeze the food mass through a shaping die at the barrel outlet. The pressures generated can rise to 350-3000 psi, causing the internal temperature to rise above the normal boiling point of water without the production of steam or loss of moisture. Under such conditions, cereal-based food ingredients will heat to 100-200° in less than two seconds and convert to a homogeneous plasticized mass.

Rice-flour hydrolysates are superior fat replacements, they mimic the organoleptic properties of fat and can be used in a wide variety of foods. The water activity of

hydrolysates is low, so biological contamination is not much of a problem.

In food process embodiments of the present invention, a slurry including rice flour is heated for a hydrolytic reaction under conditions that cleave the 1,6-linkages and separate terminal amylose groups from amylopectin molecules, and that do not cause gelatinization of the rice flour granules. At least 20%-40% of the terminal amylose groups should be cleaved, with as many as economically feasible preferably being cleaved. The cleaved terminal amylose residues seem to be responsible for the principle fat-replacement properties of the rice flour hydrolysates. Since the temperature, pressure, and reaction time variables are interrelated, a higher reaction temperature will increase the reaction rate and result in more cleavage.

Embodiments of the present invention have a water content of 5%-25%, compared to 70-80% required for traditional processing. So the simple sugars created during the hydrolysis process have a water activity low enough to mimic the texture of fat without promoting microbiological growth.

Rice-flour hydrolysates are useful in a wide variety of foods, including salad dressings, frostings, glazes, cream fillings, ice creams, margarine, cottage cheeses, yogurts, puddings, candies, sauces, toppings, syrups, cheesecakes, breads, cakes, muffins, pastries, cookies, and crackers. While these hydrolysates are primarily suited for use as fat replacements, they are also useful in other food applications such as replacements for caseinate in cheeses, and in pharmaceuticals and other non-food applications.

Commercial applications include sales to food manufacturers as a direct replacement for either vegetable shortening or animal fat. This would create a fat-free product or a reduced or low fat product with reduced